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Acoustics — Hearing protectors —

Part 6: Determination of sound attenuation of active noise reduction earmuffs

Acoustique — Protecteurs individuels contre le bruit —

Partie 6: Détermination de l'affaiblissement acoustique des serre-tête à réduction active du bruit

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

A list of all the parts in the ISO 4869 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Active noise reduction earmuffs are designed to provide additional attenuation of external sounds by means of a noise cancellation circuit. This additional attenuation is generally more effective at low frequencies. Such earmuffs can be selected for use in low-frequency dominated high noise environments.

Acoustics — Hearing protectors —

Part 6: Determination of sound attenuation of active noise reduction earmuffs

1 Scope

This document is concerned with active noise reduction (ANR) earmuffs. It specifies the test methods for the determination of the active insertion loss and calculation procedures for deriving the total attenuation. For this aim, the values of sound attenuation in the passive mode also have to be known and are determined according to ISO 4869-1. These methods are intended for steady noise exposures and are not applicable to noises containing impulsive components.

The test methods account for the acoustical interaction between the wearer and the device using measurements of passive (REAT) and active microphone-in-real-ear (MIRE) measurements as specified in ISO 4869-1 and ISO 11904-1, respectively.

2 Normative references

The following documents are referred to in the text in such way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4869-1, *Acoustics — Hearing protectors — Part 1: Subjective method for the measurement of sound attenuation*

ISO 4869-2, *Acoustics — Hearing protectors — Part 2: Estimation of effective A-weighted sound pressure levels when hearing protectors are worn*

ISO 11904-1, *Acoustics — Determination of sound immission from sound sources placed close to the ear — Part 1: Technique using a microphone in a real ear (MIRE technique)*

IEC 61094-4, *Measurement microphones — Part 4: Specifications for working standard microphones*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4869-1, ISO 4869-2, ISO 11904-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
active noise reduction earmuff
ANR earmuff
earmuff that provides additional attenuation of external sounds by means of a noise cancellation circuit

3.2
active mode
operation of the *ANR earmuff* (3.1) with the ANR circuit active

3.3
passive mode
operation of the *ANR earmuff* (3.1) with the ANR circuit not active

3.4
active insertion loss
AIL
additional sound attenuation of the *ANR earmuff* (3.1) provided in the *active mode* (3.2) compared to the *passive mode* (3.3)

Note 1 to entry: The active insertion loss is measured according to 5.4.3.

3.5
red noise
random noise signal with a spectral density that decreases by 6 dB per octave over a frequency range which does not include DC

Note 1 to entry: The definition is often phrased as noise whose power spectral density is proportional to $1/f^2$.

3.6
pink noise
random noise signal with a spectral density that decreases by 3 dB per octave, giving constant energy per octave

Note 1 to entry: The definition is often phrased as noise whose power spectral density is inversely proportional to frequency.

[SOURCE: ISO 7240-24:2016, 3.1.11, modified — Note 1 to entry added]

4 Symbols and abbreviated terms

α	Active insertion loss
A_{total}	Total attenuation
ANR	Active noise reduction
REAT	Real-ear attenuation at threshold
MIRE	Microphone in a real ear
FFT	Fast Fourier transform
APV	Assumed protection value of the hearing protector
H	High frequency attenuation value
M	Medium frequency attenuation value
L	Low frequency attenuation value
HML	Method based on H, M, L
SNR	Single number rating

5 Testing

5.1 Specimens and conditioning

Four pairs of earmuffs shall be submitted for testing. Each individual earmuff cup shall be uniquely marked for identification. The power source shall be fully operational.

All specimens shall be conditioned and tested in an environment having a temperature of (22 ± 5) °C and a relative humidity of not more than 85 %.

5.2 Test conditions

Random incidence sound field conditions at the reference point as described in ISO 4869-1 are required for all one-third-octave bands of the test signals specified in 5.3.

5.3 Test signals

5.3.1 Broadband noise for measuring active insertion loss

A broadband noise signal shall be used to determine the diffuse-field related sound pressure levels. The test signal at the reference point shall be a broadband random noise in each one-third-octave band centred from 50 Hz (or 100 Hz) to 10 000 Hz, and shall be at least 3 dB down at the one-third-octave bands below and above these limit bands, and roll off at least 12 dB/octave for the bands below and above that. Adjacent one-third-octave-band levels shall not differ by more than 3 dB. The difference between the maximum and minimum one-third-octave-band levels shall not exceed 10 dB from 50 Hz (or 100 Hz) to 10 000 Hz.

NOTE 1 Pink noise is a suitable broadband noise signal.

If the total attenuation is to be determined for the frequency range from 63 Hz to 8 000 Hz, the test signal shall extend from 50 Hz to 10 000 Hz. If the test signal is only available for 100 Hz and above, the total attenuation can only be determined from 125 Hz upwards.

The measurements described above shall be conducted with a WS2P or WS2D microphone (working standard, ½ inch, pressure field/random incidence) according to IEC 61094-4.

The use of digital pseudorandom white and pink noise sources is restricted to measurements of passive hearing protectors. Some FFT analyzers with internally generated digital pseudorandom white and pink noise sources with known statistical characteristics, i.e. wide sense stationary, can potentially overestimate the active insertion loss with some ANR hearing protectors.

The sound pressure level measured under the hearing protector (occluded condition) in each one-third-octave band with the test noise on shall be at least 10 dB higher than the sound pressure level measured under the hearing protector with the test noise off. The test signal shall be presented up to an A-weighted sound pressure level of 95 dB.

NOTE 2 Test signals up to an A-weighted sound pressure level of 110 dB can be necessary if the device incorporates a threshold level only above which the active attenuation is working.

5.3.2 Red noise for testing linear operation

Red noise shall be used with the maximum of the spectrum in the 125 Hz one-third-octave band and one-third-octave-band levels in the 100 Hz and 80 Hz band of 1 dB and 3 dB less than the maximum. The signal shall be presented up to an A-weighted sound pressure level of 110 dB.